Chapter 35
Fabrication and Processing of Pineapple Leaf Fiber Reinforced Composites

S. H. Sheikh Md. Fadzullah
Universiti Teknikal Malaysia Melaka, Malaysia

Zaleha Mustafa
Universiti Teknikal Malaysia Melaka, Malaysia

ABSTRACT

There is an increasing interest worldwide in the use of Pineapple Leaf Fibers (PALF) as reinforcements in polymer composites, since this type of natural fiber exhibit attractive features such as superior mechanical, physical and thermal properties, thus offer potential uses in a spectrum of applications. PALF contains high cellulose content (between 70-82%) and high crystallinity. However, being hydrophilic, it posed a compatibility issue particularly in a hydrophobic polymeric matrix system. Thus, their shortcoming need to be addressed to ensure good interfacial bonding at the fibers/matrix interphase before their full potential can be harnessed. This chapter summarized some of the important aspects relating to PALF and its reinforced composites, particularly the main characteristics of the fiber, extraction and pre-treatment process of the fibers. Following this, discussions on the available fabrication processes for both short and continuous long PALF reinforced composites are presented.

INTRODUCTION

This chapter is written to provide an insight about some of the past and recent advances in research and development of the natural fiber reinforced composites, with the focus on pineapple leaf fiber (PALF) and its reinforced composites. The main contents of this chapter are extraction, characterization, modification and fabrication techniques available in the literature as well the properties of various types of PALF reinforced composites. In addition, this chapter also highlights on the limitations and challenges in establishing reliable product from the proposed techniques.

DOI: 10.4018/978-1-5225-1798-6.ch035

BACKGROUND

To-date, with the growing concern to save and protect the environment, as well as with the noble notion to support sustainable manufacturing or “green” manufacturing, there is an increasing demand in the quest for finding alternative natural resources materials in developing renewable environmental-friendly composites, also known as *biocomposites*, as a substitute to the non-renewable synthetic petroleum-based composites. These efforts aid in minimizing global problems in dealing with the carbon footprint, global warming as well as waste management as a consequence of mass production of synthetic polymer composites worldwide. Such materials can be obtained from either renewable agricultural resources or waste or fully or partially degradable, hence features environmentally sustainable characteristics (Mishra, Mohanty, Drzal, Misra & Hinrichsen, 2004; Mitra, 2014; Smitthipong, Tantatherdtam & Chollakup, 2015).

Other reasons for the overwhelming attention on the natural resources materials are due to large scale agricultural production annually in the world market. As an example, pineapple is the third most important tropical fruit after banana and citrus. In addition, recent works from the last twenty years have shown that these materials can potentially be considered as candidate materials for both structural and non-structural applications, offering desirable or excellent mechanical properties, by tailoring the polymer and or fiber geometry as well as their architectures (Mishra, Mohanty, Drzal, Misra & Hinrichsen, 2004; Chollakup, Tantatherdtam, Ujjin and Sriroth, 2011; Faruk et al., 2012; Danladi and Shu’aib, 2014).

According to Summerscales and Grove (2014), there are three basic resources of natural fibers, which are animal, mineral and plant. The plant-based natural fibers can be further categorized into several basic divisions; these being bast, which is from the stem such as flex, hemp, jute and kenaf, grasses such as bamboo or wheat straw, leaf such as abaca, sisal or pineapple, seeds such as cotton or coir or wood fibers. The structure of plant fibers can be further described to exhibit a hierarchical structure with three main components;

1. **At the Molecular Level:** Cellulose (structural fibers), hemicellulose (the matrix), lignin (accumulate as the plant ages) and pectin (binder that acts as an adhesive at interfaces);
2. Individual cells with a hollow core; and
3. **Cellular Arrays:** Fiber bundles or technical fibers.

The main classes of natural fibers are illustrated in Figure 1. Yu (2015) described cellulose as “the main content of such natural fibers, which is a linear polymer, or long chain molecule, combining several 100 anhydroglucose units”, and regarded as the major component of reinforcement fibers.

The properties of a composite are dictated by the intrinsic properties of the constituents, with the main aspect being fiber architecture and fiber matrix interface. In addition, in a composite system, the reinforcing efficiency of natural fibers very much depends on their physical, chemical and mechanical properties. Sapuan et al. (2011) highlighted that some of the major drawbacks of natural plant fibers are “fiber non-uniformity, variation in properties, low degradation temperature, low microbial resistance and susceptibility to rotting”. Moreover, they added that fiber extraction and processing techniques also strongly influence the final quality of the fiber and its cost and yield. Another important issue to overcome when using natural fibers with polymer matrices is poor fiber-matrix interfacial adhesion, which could lead to inferior mechanical and other properties of the composites.